NOTES ON NATURAL HISTORY

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ON

NATURAL HISTORY:

SELECTED FROM

THE "MICROSCOPIC CABINET."

ILLUSTRATED BY

TEN COLOURED ENGRAVINGS, FROM ORIGINAL DRAWINGS

MADE BY

C. R. GORING, M.D.

BY ANDREW PRITCHARD, M.R.I.,

AUTHOR OF "MICROSCOPIC ILLUSTRATIONS," "A HISTORY OF INFUSORIA, LIVING AND FOSSIL," ETC.

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PREFACE.

THE following pages, part of the *Microscopic Cabinet*, are presented to the public, in the hope that they may prove interesting to those who do not desire to peruse the part on Practical Optics contained in that work.

The reader will probably consider the Author as justified in this undertaking when informed that these Essays have been lately translated and published in France, at the expence of an eminent Artist residing there. A selection from that work has also been translated and published in Germany.

At the time of the publication of the *Microscopic Cabinet*, little attention was paid by scientific men to microscopic pursuits :—indeed, it was then not un-

common to meet with a sneer on the bare mention of the microscope. It was, therefore, natural that the Author and his colleague (the late Dr. Goring), should meet with little encouragement from such men. They persevered, however, and placed the microscope in as respectable a position as the telescope, before the observers and artists of the present day entered this field; it is also probable no small share of the vast benefits since derived by the aid of the microscope in the investigation of the Animal and Vegetable Kingdoms is due to the *Microscopic Illustrations* and *Cabinet*, if considered merely as pioneers. Now the public has taken up this subject, and it has become fashionable, there is no lack of labourers.

The following paragraphs from the preface of the *Microscopic Cabinet*, will

serve to introduce the reader to these "Notes":—

"The study of the works of the Creator can need no apology; of whatever class or dimension, they evince the same infinite power and wisdom in their production Some portions, it is true, present greater diversities in their forms, and enable us to penetrate deeper into their structure and organization, than others—displaying more beauty in their forms and colouring—more delicacy—and a higher degree of finishing. In these respects, the specimens selected for this work are not exceeded by any.

"While almost every part of nature has within the last few years been explored, and our knowledge augmented, the living objects described in this work have been nearly overlooked by naturalists, and such representations as we

possess of them are delineated in the most incorrect and grotesque manner that can well be conceived; for these reasons the Author has presumed to call the attention of the public to this interesting branch of Natural History.

"The first thirteen chapters are devoted to the description of the Aquatic Larvæ of Insects, Crustacea, and Animalcules. The reader is requested to consider them merely as popular outlines of their general characters, chiefly collected from the Author's own observations. This was considered preferable to a scientific display of terms, or a lengthened history, which many persons might not be disposed to follow. To some of these classes are prefixed, for the information of the general reader, a few cursory remarks on arrangement," &c.

London, 162, *Fleet Street.*

NOTES

ON

NATURAL HISTORY.

SECTION I.

ON THE LARVÆ OF INSECTS.

This section comprises descriptions of insects in the larva or pupa state. To those who are unacquainted with these subjects it may not be amiss to give a brief outline of their general characters, though it must be borne in mind, in the perusal of this work, that it is not intended to treat the subjects on natural history technically, but familiarly.

The term insect has been greatly restricted by modern naturalists. Many groups, which Linnæus and others included under that name, have been separated from them, as spiders

(*Arachnoidea*) ; crustacea; mites (*Acari*) ; and centipedes (*Myriapoda**) ; which were included among the apterous, or wingless insects. This rejection has been made from a more accurate examination of their internal organization, and the word *insect* is now confined to animals whose respiration is performed by two tracheæ, or air-tubes, which run parallel to each other, the whole length of the body, occasionally sending off ramifications. These receive and emit the air through apertures (*stigmata*), placed at intervals along the sides, or near the tail. As air-vessels pervade the body, a *complete* circulation of a vital fluid is not required, its æration being effected by air carried to it, and is not, as in the larger animals (*vertebrata*), collected into one great vessel, and then subjected to its action. Some observations on this subject, with illustrative engravings, will be found in chapter 3 of the new edition of the "Microscopic Illustrations."

The nervous system is composed of two cords, united at certain distances, where an enlargement (*ganglion*) occurs, which sends off various branches to the surrounding parts. The head in insects is distinctly separated from the

* These are still included (but in a distinct order) by Cuvier.

body, and is furnished with two antennæ, or horns. True insects have only six articulated thoracic feet, and all of them, except the orders *Thysanura* and *Anoplura*,* of Dr. Leach, undergo certain changes or metamorphoses (more or less complete) before they arrive at their final or perfect state, in which alone they are capable of propagation. In the first state they are called larvæ, worms, grubs, or caterpillars; the second, pupæ or crysalides, in which they are mostly inactive; and the last is the imago, or perfect insect. Their distinctive characters in this latter condition are the basis on which entomologists have classified them into orders, sections, families, genera, and species. The most minute differences have been recorded of the perfect insect; but, in the first or larva state, the descriptions are so meagre, especially of the aquatic, that in many instances it is impossible to ascertain the precise species to which they belong. This, however, is of little import in the view here taken of them.

* The order *Parasita* of Cuvier and Latreille. These are not included with insects by later entomologists.

CHAPTER I.

ON THE LARVA OF A SMALL SPECIES OF DYTICUS, POPULARLY NAMED THE CROCODILE.

The appellation of crocodile to this curious larva has arisen from its general resemblance, under the microscope, in colour and form to that terrific amphibious animal; the sudden springs and starts which it makes assimilate it also in manners. The scientific name of the family to which this aquatic beetle belongs is *Dyticidæ*, a term derived from their habits; all the species in their perfect state being observed to dive or plunge into their watery element when approached.

The eggs from which these larvæ are produced may be found, during the spring and summer, adhering to aquatic plants, and to confervæ growing near the surface of the water. They are enclosed in a species of bag or cocoon, rather smaller than the common pea, of a dusky white colour, and are prevented from floating away with the current by a slender filament, which attaches them to the herbage.

If a few of these eggs are deposited in a vessel of water, and exposed to the sun, in favourable weather, they will be hatched in a few days. When the young first make their appearance, the head is larger and the tail longer in proportion to the size of the body than when full grown; they are now remarkably active; at this period, if about half a dozen be put into an aquatic live-box, with a sprig of moss, as directed in the "Microscopic Cabinet," they will afford an interesting spectacle under the microscope. When a few days old they shed their skin, and after the operation, which occupies some time, they are almost colourless, especially about the head; their activity forsakes them, and they abstain from food. As they recover, they gradually assume their variegated tints. If they are now supplied with one or two small blood-worms (larvæ of the *Chironomus plumosus*), and placed under the microscope, an alternating motion of the glottis will be perceived, and, as the digestion of the coloured fluids of the worm proceeds, the alimentary canal, the different vessels, and their ramifications, will acquire distinct colours, forming a strong contrast with the transparent integuments surrounding them.

The difficulty of distinguishing between the ova of different species of aquatic insects, and the trouble of discovering them, by reason of their close adherence to the water-plants, render it advisable to collect the larvæ rather than the eggs, when desired merely as a microscopic object. For this purpose, the vegetation growing at the bottoms and sides of ponds, marshes, and slowly-running brooks, should be carefully collected and laid on the banks, or, which is preferable, on a white cloth spread to receive it, and then carefully examined. They often creep into small crevices and holes in the roots and branches, to avoid discovery. At other times they will remain motionless on a part of the plant of their own colour, and thus endeavour to avoid detection. As they move with great rapidity when disturbed, they must be taken up quickly with a feather, or the net-spoon, and put into a reservoir.

The disposition of these carnivorous larvæ is fierce and cruel; hence, if they are inadvertently placed in a vessel with other aquatic insects, the collector will find, to his regret, the latter either destroyed or injured.

The magnified view of this larvæ, represented in *plate* 1, was taken soon after it had cast its

first exuvia or skin, a time at which its vessels and internal organization are, on account of the thinness and transparency of its recently-developed skin, more distinctly perceptible than at any other period of this creature's existence. Its pre-eminent qualities as a microscopic object are now exhibited in the greatest perfection; its anatomical structure is more delicate and beautiful than in any other larva of the Coleoptera order, and although its weapons of attack are not so formidable in their appearance as in some larger species, yet the distinct manner in which its internal functions are displayed, more than counterbalance this trifling inferiority.

Before entering on a description of the drawing, I should remark, that no figure of this species has appeared in print, at least in the state here given.* All its internal structure, as exhibited in the living subject, is delineated with the utmost fidelity; and so minutely are the details preserved, that a magnifier is necessary to show them.

This larva is armed with a pair of bent for-

* In vol. iv., plate 31, of Reaumur's Memoirs of Insects, is represented a larva of a Dytiscus, something like this, but devoid of any internal display. Also Moses Harris has a figure, in plate 26 of his work on Insects, of a species apparently not very remote from this.

ceps or mandibles, as shewn in the engraving; they move horizontally, and are long enough to cross each other when closed; they are of a bright chesnut colour, assuming a deeper hue towards the points, which are hard and sharp.* With these weapons it seizes its prey, and, having brought it towards the mouth, it commences the operation of exhausting the juices from that portion within its grasp, having previously made an incision with the mandibles. This larva does not kill its victim before eating it, unless compelled by the superior strength of its prey, but, taking hold of any part indiscriminately, it devours that portion while the animal is alive. Having so done, if its victim be the larva of a gnat, or other soft animal, it turns it round, and thus brings a fresh portion within its grasp, alternately opening and closing each mandible, till the whole is consumed, except the skin. If the prey is a strong crustaceous animal, it seizes it, and either holds it for some time stationary, till it is exhausted, or nips off, at successive grasps, all its limbs, turns it upon its back, and imbibes its contents. The fore part of the head is finely

* In some of the larger species, says Swammerdam, the mandibles are perforated by an oblong hole or slit, by which they imbibe the juices of their prey.

serrated, as shewn in the drawing; but whether these processes perform the office of teeth, I am not certain. The palpi, or feelers, situated about the mouth, are flexible, and composed of four articulations, as shewn at *a;* they are very transparent, especially about the joints. The eyes are disposed in two clusters of six each; in some specimens they are placed at equal distances from each other, forming a circle; while in others three or four are blended in one group, and the rest a little separated. The head, when viewed laterally, is flat, and slightly tapering, and is so transparent in the infant larva, that the palpi are seen through it. It is connected with the first segment or prothorax by flexible muscles, which allow it to turn horizontally or vertically; the latter, however, is the most usual motion. In the thorax or corselet, composed of the three anterior segments, are placed the ganglia, or nervous cords, terminated by loops. They are very perceptible in the young larva, as may be seen in the drawing, and are of a brighter colour than the other parts. The two large vessels, or tracheæ, originating in the head, here attain their greatest development, and proceed along the succeeding annuli, forming the abdomen, to

the other extremity, where they meet and terminate. During the progress of these air tubes they send off numerous ramified branches, as displayed in the engraving. The inner pair of vessels commence at the ganglia, and lose themselves in the third segment from the tail. In the penultimate annulus is situated the pulsatory organ, which by some zootomists is considered to be the true heart of insects, but, from the examination of Cuvier and others, it appears to have no communication with the main vessels of the insect, and hence cannot be an organ for circulation. It is termed by him the "dorsal vessel," and its function, according to Marcel de Serres, is the secretion of fat, which is afterwards elaborated in the adipose tissue that envelopes it.

To the under-side of the thorax are attached six transparent crustaceous legs, marginated with fine bristles, placed at short intervals, and having strong spines at their articulations. They are also terminated by strong ciliated claws, and a delicate ramified vessel runs through their whole length; the tail is composed of two processes or spines, having several smaller ones branching from them. When one of the larger spines is destroyed, I have ob-

served it to be replaced by another, which, however, seldom attains the size of the former.

These larvæ feed on almost every other kind, and, in their turn, are devoured by the larger water-beetles (*Dytiscus marginalis* and *semistriatus*). Their favourite food is the larvæ of the ephemera* and gnat. On the other hand, even when kept without food, they refuse monoculi, preferring to feed on each other. From this propensity, if confined in separate vessels for a few days, and afterwards put together, the most fierce and obstinate combats ensue. In these engagements the little animals display all the courage, skill, and caution of two well-trained pugilists, turning about with extended jaws, till a fit opportunity occurs for attack. Their courage is such, that I have seen a small one seize another twice its size, and hold it for several seconds. When, however, they are of equal size, and exceedingly pressed by hunger, the contest will be continued for several minutes, and, to the lovers of such sports, will be found not inferior to any; and when viewed on the screen of a solar or gas microscope, several spectators can witness it at the same time, and make their observations and remarks as the battle proceeds.

* An elegant species of this larva is figured in the "Microscopic Illustrations."

They move with great rapidity, both in running and swimming, and in the latter they are assisted by their tails. In rising, which they do occasionally for the purpose of respiration, they seem to beat the water, and sometimes hold their tail above its surface, to admit fresh portions of air into the tracheæ, by the stigmata or orifices near that part. In warm weather they creep up the stalks of plants, and remain near the surface of the water, delighted to bask in the genial rays of the sun, while in cold weather they retire to the bottom, concealing themselves in the mud, where they remain in an almost torpid state.

As they advance to their full size their motions become sluggish, and if at this time they should be infested, as is very common, with the clustered Bell-polype (*Vorticella convolaria*)* these parasitical animalcules will rapidly increase in number, to the great annoyance of the larvæ. In a similar manner, when the larvæ are kept in vessels too small to permit them to take sufficient exercise, the Bell-polype become so numerous as to occasion disease. As a microscopic object, however, these parasites add materially to the interesting characters which it displays. Their appearance, to the

* General History of Animalcules, figures 237 to 243.

unassisted eye, resembles a species of down, or mildew, surrounding the animal. If touched with the point of a feather, the mass becomes whiter and diminishes in magnitude. The cause of this change is readily discovered under the microscope. In the first instance, the parasites were extended at the extremity of the filament that attaches them to the animal, and consequently dispersed over an extensive surface; in the latter case, they approach the animal by bending or coiling the connecting filament, and thus reducing the size of the mass.

Our knowledge of the transformation of these aquatic coleoptera is very limited; Rœsel and Swammerdam are the only naturalists that have left any record of their change; and even their accounts are partly conjectural. They state, that the larvæ, when mature, bury themselves in an oval cavity formed in the earth on the sides of their natal ponds or marshes, and there undergo their first change into a chrysalis, and after remaining a proper time in this quiescent state, emerge from the earth a perfect beetle. The appearance of the complete insect has no resemblance to that of the larva; indeed, so different are they in the two states, that not only have casual observers been deceived, but Dr. Shaw informs us, that even the early writers

on entomology have classed the larvæ with fresh water shrimps, under the name of *Squillæ aquaticæ*.

The body of the perfect insect is short, and furnished with wings, covered by shelly cases (*elytra*). It has two compound eyes, and is amphibious; it, however, seldom takes flight or leaves the water in the day-time. The feet, which are long, have the tarsi composed of five articulations. The four anterior feet of the males in the larger species (*marginalis*), are furnished with spongy cups. They swim with great rapidity by the assistance of the hinder legs, and being sharp-sighted, pursue every aquatic insect within their reach.

Modern entomologists have divided these pentamerous insects into several sub-genera, and enumerated various species in the *perfect* state, the systematic distinctions of which it is not the province of this work to describe. The difference between the smaller species (which are numerous), in the larva state, is unknown. I am inclined to believe that this subject is the *Dytiscus minutus* of Linné, or the *Laccophilus minutus* of Dr. Leach. These larvæ, when preserved in Canada balsam between slips of glass, become permanent microscopic objects.

CHAPTER II.

LARVA OF A SPECIES OF SMALL GNAT OR TIPULA, HITHERTO UNDESCRIBED.

This creature presents a peculiarity in structure, which distinguishes it from any other with which I am acquainted. Its singularity consists in its very distinct division into annuli, and in its strong corded appearance, which, together with its beautiful star-like tail, small dark eyes, perviosity to light, and elegant evolutions, render it a choice subject for microscopic examination.

These larvæ are generally met with, during the summer, in ponds and ditches in which there is an abundance of healthy vegetation, creeping among the stalks of aquatic plants, but particularly in clear waters covered with duck-weed.

In collecting them, a quantity of the herbage should be taken with a cloth net, or bason, and put into a deep vessel of water. In a few minutes they will disentangle themselves from the plants, and may then be removed to a con-

venient reservoir, or they may be separated from aquatic plants without an additional vessel, by spreading the plants on a white cloth, placed in the sun. In a few seconds they will creep out, and may be taken up on the point of a feather. Of these two methods the first is the best; for, unless great care be taken in removing them with the feather in the latter method, their delicate bodies will be injured. When it is desirable to preserve them alive for some time, a portion of the plant must be kept along with them: this will furnish them with food, as there is generally an abundance of animalcules about their roots.

They may be caught at most seasons of the year, but in severe cold weather, they descend to the bottom of the water, and remain inactive.

Plate 2 exhibits a magnified view of one of these larva in a position that it frequently assumes, and also one of its natural size. When recently taken, in a healthy state, it exhibits the colours shewn in the drawing, which, however, it gradually loses, if kept in a small vessel. It is composed of twelve segments; the first is connected to the head, by a ring or neck, shorter than the annuli. When the larva turns

its head sideways this intermediate link enfolds itself within the first segment, without disturbing its position. The skin of this animal is covered with a series of longitudinal stripes or cords, as shewn in the engraving. From this structure it happens, that, when the larva twists or turns part of its body, the segments in those places become less transparent, the longitudinal lines assuming a spiral direction, and presenting the appearance of a many-threaded screw, while the under and upper ones, crossing each other, stop a portion of the light. On reassuming its straight position, its transparency is instantly restored. These alternately opaque and pellucid appearances seem, at first glance, to arise from a power in the creature to change its colour, but explained as above, which may be verified by means of a strong magnifier: the mystery vanishes, and we see how admirably Nature has adapted its structure for the purposes intended; for, were it not for these longitudinal cords, in turning or twisting, a considerable pressure, and consequent injury, would have been sustained by its internal parts.

The head is furnished with two pair of eyes; the anterior ones, which are situated near the mouth, are smaller than the others. Two large

vessels, running the whole length of the larva, have their origin in the head, and the ramification commences near the eyes. Throughout the animal a peristaltic motion is perceptible; its interior appears to be one large canal, having the vessels running along each side of it; the tail consists of nine strong bristles, each tapering to a point; they are transparent, and, when viewed under a deep magnifier, appear like hollow tubes, without striæ or markings of any kind. The animal has the power of closing all these bristles into a bundle, and, from the instantaneous manner in which this is accomplished, casual observers have supposed them sheathed within the last segment of the body.

As general microscopic objects, few will be found to afford more amusement; placed in an aquatic live-box, with a sprig of moss or confervæ, they form an entertaining spectacle, entwining themselves among the moss, and darting about in various directions, withdrawing and spreading out the tail, &c. If put in the same aquatic slider with the larva of a Dytiscus, the latter may be seen in pursuit of them, and destroying all within its reach.

They seldom require more amplification than

that of a single lens of a quarter of an inch focus (viz. forty times linear measure). If the instrument is a compound one, or engiscope, and a sprig of moss is employed, it must be fixed in an *inverted* position, by a little cement or sealing-wax in the aquatic slider, in order to appear erect through that instrument.

I am not aware of any account of the transformation of this insect in print; indeed some consider it as a species of Nais, which does not undergo any metamorphosis. From my own observations, I find the larvæ change to pupæ in the month of May. In this state it is shorter than in the former, and has some resemblance to the pupa of the Tipulidan gnat (*Corethra plumicornis*), figured in the "Microscopic Illustrations." It is, however, devoid of its membraneous tail, and differs also about the head. When about to change, they fix themselves in the crevices of some floating body, to assist them in casting their exuviæ. The pupæ are rather inactive, and float near the surface of the water, with their head erect. Immediately after their transformation they are of a pale colour, but in a few days they become of a deep brown. In this state they may be preserved between glass and talc, as also the larvæ, and the skins

which they shed. The latter are extremely diaphanous, and the former furnish excellent substitutes, when living specimens cannot be procured. In Canada balsam they are difficult to prepare.

CHAPTER III.

THE LARVA AND PUPA OF A BEAUTIFUL SPECIES OF LIBELLULA, OR DRAGON FLY.

Libellula grandis.—*Linné.*
Æshna grandis.—*Fabr. and Leach.*

Among the numerous species of the family Libellulidæ, the larva and pupa of that which forms the subject of these remarks stand pre-eminent as objects for microscopic examination, both on account of the elegance of their form, and the variety and brilliancy of the tints which adorn them; while the possession of a sufficient transparency to exhibit a portion of their internal organization, and a distinct view of the ramifications of the air-vessels (*tracheæ,*) which pervade the delicately marginated appendages of their tail, together with the peculiar structure of their weapons and manducatory organs, render them curious and highly interesting examples of the diversified contrivances that Nature displays in the insect creation.

The eggs are deposited in the water by the parent fly, who, hovering over a selected spot,

immerses the lower extremity of her body, and deposits, at intervals, a single egg. These eggs, when examined by a microscope, appear of an oblong form, having the fore part terminated in a point of a blackish colour.* The young, when they first emerge from the ova, are very small; indeed, are almost imperceptible. In a few days they grow to the length of the tenth of an inch, and cast their exuviæ the first time. I have taken them of this size, in the months of June and July, sporting in ponds containing healthy aquatic plants. If these creatures be examined at this period, their heads will be found much larger, in proportion to the body, than at a more advanced stage of their growth. Indeed, by unassisted vision, they now appear like dark specks, having a tail attached to them. They grow rapidly if well supplied with food, and, when about two-tenths of an inch long, begin to exhibit all the courage and ferocity of the mature larva, attacking with extended jaws beings ten times their own size, and, when incommoded, even destroying those of their own species.

The ramifications of the two large vessels (*tracheæ*), running along the back, are now

* Swammerdam's Book of Nature, p. 98.

distinctly developed in the head, and a larger branch to each eye. These vessels are double, and each separates into two at the commencement of the second segment or *mesothorax*, but they afterwards unite a little lower down, first sending out a branch to each of the middle pair of legs, which have their insertion in this segment. The first pair of wings subsequently emanate from this part, which may account for the division of these vessels. The re-united vessels proceed onward to the posterior extremity of the body, and then beautifully ramify over the three membraneous appendages of the tail, each appendage being furnished with a branch from *both* the tracheæ. The larva of the Ephemera marginata have a series of smaller leaf-like appendages, on each side of the body (see "Microscopic Illustrations," fig. 7), which are considered to perform the office of gills. It is, therefore, exceedingly probable that these tails of the Libellula, which are similar in appearance, perform the same office, although they do not exhibit that vibratory motion which is produced by the ephemera.

In the infant larva these caudal appendages are not developed, but consist of three tubular spines, with smaller ones proceeding from them.

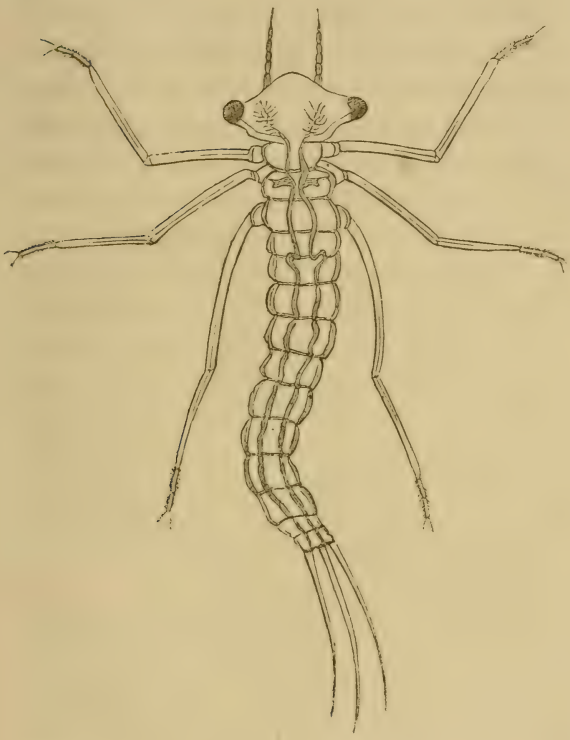
The first and second exuvia which it sheds exhibits the structure of these spines very distinctly, and, from its transparency, allows of considerable amplification.

The larvæ of the Libellula depressa, and some other species, are devoid of these leaf-like appendages. They possess a curious hydraulic apparatus, which *Reaumur** informs us they employ for propelling themselves, and also for respiration. This apparatus, which forms the cavity of the lower part of the abdomen, it can dilate or contract at pleasure. When closed by the muscular action of the larva, the water with which it was previously filled is expelled, and, by its action against the stationary fluid, the creature is urged forward; when again dilated, a fresh portion of water is admitted, and the *pumping* is repeated, at the will of the creature. The anatomy of these parts, by which the air is absorbed for the purpose of respiration, is briefly described by Kirby and Spence, in vol. iv., p. 16, of their Introduction.

The young larvæ of the Libellula grandis swim with great activity, inflecting the body laterally as they advance, and assuming the position exhibited in the annexed sketch, the

* Reaumur Mem. Insects, vol. vi.

third pair of legs being brought near the body by the resistance of the water.



This larva, which is here represented magnified, is about two-tenths of an inch long; its

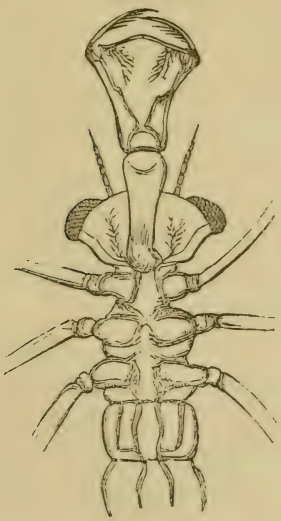
antennæ are straight and stiff, and the eyes are much smaller in proportion to the size of the head than at a later period of its existence. As it increases in magnitude, the wings are gradually developed, and it is then termed the *pupa*. In proportion as it approaches its transmutation into the perfect fly, it becomes sluggish in its motions, and often remains stationary on the stalks of plants, with its head directed downwards, eluding observation, from its colour approximating to that of the plant on which it rests. At this period it evinces much cunning in the gratification of its predaceous appetite, which ceases a short time previous to its change.

During its growth it casts its skin several times. These exuviæ are beautiful objects for the microscope, as they are quite transparent, and exhibit the prominences, depressions, and markings of every member, being, in fact, a perfect mould of the creature.

The magnified representation of this Libellula, given in *plate* 3, was taken just before its transformation to the perfect fly. This period was selected, as the brilliant colours which adorn it had attained their maximum of intensity, and the immature wings, with their envelope, were most perceptible. It measured eight-tenths of

an inch in length from the tip of the antennæ to the end of the tail. As the details are accurately preserved in the engraving, it would be superfluous to recapitulate the form and number of its members, when a more accurate idea can be obtained by inspection, observing, that, as the drawing is a side view, the broad figure of the head (see the sketch) is foreshortened.

As the most curious part about these larvæ, at least as regards their external organization, cannot be well shewn in the drawing, it is re-



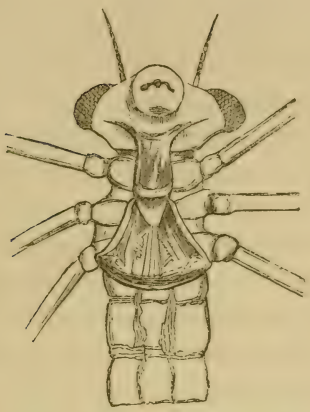
quisite to describe it here, for the illustration of which I have made two sketches of the different parts.

The mouth is situated on the inferior surface of the head, and is concealed from view by a peculiar piece of apparatus, denominated by naturalists the *mask;* it is composed of several pieces, and its structure varies in different species: in the present one it consists of two corneous plates, terminated by a pair of forceps. The form of these plates, extended outwards, is shewn in the annexed figure, which represents a magnified *nether-view* of the head and thorax, and the first two integuments of the abdomen.

The first piece of this manducatory instrument is attached to the head, near the prothorax, by a strong joint; this plate, in its natural position, is thrown back, and covered by the second plate, to which it is attached by a joint; it is convex externally, but concave next the mouth, whereby the juices of its prey are more easily conducted to it.

In the following view the parts are thrown back, to show the mouth and internal structure of the plates; the forceps, which terminate the second plate, lying upon it, are not very distinctly seen. It must be remembered, however,

that this position is never assumed by the animal.



In the *Libellula depressa*, instead of *a pair* of forcipated jaws attached to the extremity of the second plate, there is a pair of triangular plates, each piece or plate being attached by one of its angles, and forming a joint, which, when closed, permits the opposite sides of the triangles to meet, and, being dentated along the sides in contact, they fit into each other.

The use of this curious organ is for seizing their prey, a purpose which they effect with much caution, stealing upon it till it is completely within their devouring grasp, then seizing it with their fangs, and, bringing it to their

mouth, they speedily devour it. They are very courageous. I have sometimes seen them, when pressed by hunger, attack larvæ of the Dytici of nearly double their own size. If kept in a glass jar without food, they will devour each other, first destroying the tails. The ravages they commit on their less offensive neighbours would soon exterminate many genera if they were as prolific as they are voracious. The all-wise Creator has limited the increase of these carnassial insects, the perfect fly only laying about two dozen eggs, while the number produced by some herbaceous tribes amount to as many thousand.

The colour of these larvæ when young, is ferruginous, with markings, at intervals, of a deeper brown. As they increase in size, the wings make their appearance, and the head begins to assume a brilliant variegated transparent green; after this, the body gradually exhibits the same hue, as shewn in the drawing. The ramifications in the tail, and the two vessels running along the body, assume the rich warm colouring there shewn—an effect which is greatly assisted by being contrasted with the transparency of the surrounding parts. From the splendour of these tints, and their

carnivorous habits, they have obtained the name of *King-fishers.*

The eyes of these creatures are very prominent, both in the larva and final state; and, from their size and curious structure, afford excellent objects for microscopic examination. In the perfect insect they have been a fruitful object of study to naturalists. They are immoveably fixed on each side of the head, and are compound, each consisting of numerous distinct smaller ones. They are externally convex, and it has been observed by Latreille, that the eyes of insects in general are "by so much the more convex as the insect is more carnassial." Under a low magnifier the surface appears reticulated, which, on minute examination, is found to arise from hexagonal cells, each forming a separate eye. Leeuwenhoek states that he has counted twelve thousand in one individual. The cornea consists of lenses possessing all the properties of those made of the usual transparent media, forming an image of bodies in the same manner, and capable of being employed as magnifiers. These interesting facts may be observed, by placing any object under the eye of the insect, and viewing it in a microscope, when each of the minute lenses

of the eye will form an inverted image of the object employed. By separating one of these lenses, and forming an inverted telescope with it, using a magnifier of low power as an eye glass, and the eye of the insect as the object-glass, and adjusting their distance, a distinct view of objects at a moderate distance may be readily obtained. In this way, the focus of the eye may be found, as in the case of common lenses, if we know the exact power of the eye-glass:—for example, if this magnifier is the one-twentieth of an inch, and on looking through this inverted telescope at the window bars, you find (*keeping both eyes open*) that three of the squares of glass are exactly equal in length and breadth to one seen by the other eye at the same time without the telescope, the two images being brought apparently to overlap each other, the focal length of the eye under examination will be one-third of the eye-glass, or one-sixtieth of an inch. I regret that I have not measured the focal length of the eye we have been describing, but in the common house fly (*Musca domestica*) the lenses are each about the one-hundredth of an inch focus. In preparing the compound eyes of insects, it is requisite to soak them for some days in water, to render them

supple, and then to wash out the black pulp (*pigmentum nigrum*), with a camel's-hair pencil, when they may be mounted.*

To give a description of all the minute parts of this larva that would interest a true lover of Nature would occupy a volume. I cannot, however, omit to notice the singular structure of the bristles which adorn their feet. They are branched, or serrated, like those on the bodies of certain flies (*syrphi*) and plants, a beautiful example of which is afforded on the petals of the flower of the scarlet chick-weed. In the Libellula their form is constantly the same in similar parts; hence, we may infer, they perform a specific office. Thus those about the joint, at *a*, *plate* 3, are strong tridents, without any serratures or spines; while those that border the next joint, *b*, are formed in the curious manner shewn in the annexed figure, which is a highly magnified view.

The trident hairs lie on the inferior side of

* It appears, from some recent dissections of compound eyes, that the plates which compose the cornea are distinct lenses, each capable of forming an image; a tube is placed behind them, and *another lens* at the opposite end. A favourable example of this construction is the pedunculated eye of the Craw-fish and Lobster. It is difficult to find a subject more interesting for microscopic investigation than the dissections of compound eyes.

the foot, and in the dry limb are barely perceptible, from its opacity; as, however, in casting the exuviæ, these insects also throw off the covering of these hairs, they are exhibited in them with great effect.

The transformation of the pupa to the perfect fly is accomplished in the short space of a few minutes, and is an occurrence that is seldom observed. At the period of the change, it crawls out of the water, and fixes itself by its claws to some adjacent plant, and after remaining a few seconds it becomes dry, and the skin along the back separates, allowing the head and legs and part of the body of the perfect insect to be protruded, while the empty skin of the feet remains firmly fixed to the plant; it now

remains stationary for a short time longer, while the wings expand and unfold themselves; the remaining parts are then liberated, and when sufficiently extended and dry, the perfect fly soars into the atmosphere.

This fly has four reticulated wings, and is equally predaceous with its larva, feeding on butterflies and other insects. They may be taken, in June and July, on plants and on the banks of ponds:—they are vulgarly called horse-stingers, though entirely destitute of a sting. The French give them the name of *Demoiselles*; surely our neighbours are too gallant to name them thus from the very amiable habits they exhibit in wantonly destroying every inoffensive insect they meet. In courtesy we must suppose it is from the elegance of their form, and the brilliant colours which adorn them.

For microscopic observation this larva possesses much interest, in exhibiting, in a very distinct manner, diffused circulation. This is well shewn in the legs, especially the joints next the body. The mask, eyes, rudimentary wings, and the leaflet tails, afford permanent objects when mounted in Canada balsam.

CHAPTER IV.

THE LARVA OF A SMALL NOTONECTA OR BOAT-FLY.

Notonecta minutissima.—*Linné.*
Plea minutissima.—*Leach.*

The rich transparent and brilliant colouring of these insects, both in the larva and perfect state, when they have newly cast their skins, the agility of their movements, and the peculiarity of their habits, excite an interest inferior to none in this department of animated nature.

These insects swim on their backs, whence they derive their name. At first sight their appearance is not unlike that of a boat; the hinder feet, which are adapted for swimming, are formed like feathered oars; and are used by them with much facility and elegance. They are constantly on the alert, and dive to the bottom of the water on the slightest alarm.

During the spring, they are found in ponds and rivulets, and may frequently be seen in droves descending to the bottom, on the approach of a spectator. They may be taken in a hand net, though not without considerable

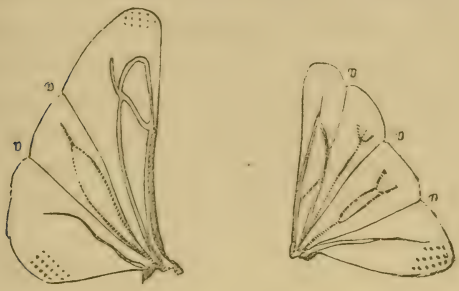
adroitness, unless by accident. About the months of September and October, they arrive at their perfect state, when their colouring is much heightened. At this period their eggs may be discovered in the water, adhering to stones; they are small, and have a gelatinous appearance. During their progress to maturity, they shed their skin several times, and are then quite colourless, except the eyes, which are light crimson; they afterwards gradually assume their proper colouring, and the abdomen undergoes all the variations of tint from a pale yellow to a rich carmine.

The body is of a "squarish oval" form, as represented in the magnified view of its underside, in *plate* 4, *figure* 1. The head is narrow and furnished with two prominent reticulated eyes of a deep crimson colour, approaching to black. It has three pair of feet; the first pair are short, and thickly beset with hair, and their articulations equally distant. From their colour, and the position they assume, they often elude the sight. The second pair of feet, in swimming, are usually laid downwards, as shewn in the drawing. The hinder pair, or swimmers, are the strongest; they are ciliated along their margin, and terminated by large claws.

The rostrum, or beak, is hard and pointed. In some of the larger species it has sufficient strength to effect a severe puncture and wound. As this part is foreshortened in the drawing, I have here given a sketch of the head and rostrum of the *Notonecta glauca* magnified. Its covering is of a strong corneous texture; it has a channel down the middle, and is terminated by a strong hard point; the eyes are prominent and compound.

The wings of the perfect insect are delicate and transparent; they are folded under the wing cases, which overlap each other along the anterior margin; they are variegated in some species, and striated in others. The folds of the wings are shewn at *a* in the following figures; the larger one is the wing of the *glauca*,

and the smaller one the *Notonecta striata*, both magnified.



The body of this insect is fringed with long hair, and on each side, and down the middle of the abdomen, are disposed thick rows of the same. In the larger species they are very perceptible; their office appears to be that of buoying the insect on the surface of the water without requiring any muscular exertion, which is performed in this manner:—The insect rises to the surface, and elevates the inferior extremity of the body; then lifting up the side rows of hair, it permits a portion of air to enter the channel which they previously occupied, and there retains it. When it wishes to sink, I observe that it strokes down the fringe with the feet, and thus liberates the air, by which means,

their bodies becoming specifically heavier, they descend. The contemplation of contrivances such as this, so admirably calculated to effect their intended end, must surely elicit the highest admiration of the works of the Creator, even from the most obtuse and thoughtless. Many fish possess an air-vessel, which, through the aid of proper muscles, they have the power of compressing or dilating, to facilitate their ascent and descent. In these insects the same purpose is effected by the simple law of capillary attraction only.

Both in the larva and perfect state this insect feeds on the eggs and small aquatic larva of insects, and the thoughtless victim is often captured in descending to the bottom of its element, by the wary position in which its destroyer places itself, with its rostrum upwards, ready to commence an attack. The eggs are their favourite food; these they devour with avidity, as soon as they are emitted by the parent, even before they reach the bottom of the water.

The species belonging to this family (*Notonectidæ*) are numerous, and most of them are inferior in interest, as microscopic objects, to the one here figured. Dr. Leach has separated

them into four genera, viz. the Notonecta (proper), Plea, Sigara, and Corixa, which it would be out of place, in a work devoted to the microscope, more than to name. His paper, which displays much erudite knowledge of systematic arrangement, may be consulted in the twelfth volume of the Transactions of the Linnæan Society.

SECTION II.

ON ANIMALCULES OR INFUSORIA.

The two succeeding chapters are devoted to that minute class of living beings denominated *animalcules*. This term admits of great latitude. It is not confined to that numerous tribe of aquatic animals which are wholly invisible to unassisted vision, but is applied to all whose members require the aid of a microscope to render them manifest. Some have preferred the term *infusoria*, they being always found in infusions of vegetable or other organized matter, and have defined them as mere active gelatinous matter, devoid of any muscular, digestive, or nervous system. A careful examination, however, under a good instrument, will show that all of them are possessed of digestive organs, and many, especially some species of the Vorticella, are highly organized. At the same time, it cannot be denied that some functions, which in the larger animals require distinct organs for their performance, may in these be effected by a peculiar conformation of the integuments which envelope them, their

surface being so very great compared with the quantity of matter they contain.

Otho. Fred. Müller, the Danish naturalist, was the first who arranged the infusory animalcules. His classification and descriptions are accompanied by drawings of each species, which render his work, even at the present day, the most valuable we possess, although his arrangement has been extended and improved by succeeding writers. The basis of his division is, their external characters, and the structure of their envelope.

Since the year 1780, the date of Müller's work, very few facts have been added to this part of natural history. The great advance to perfection, which the microscope has recently made, and the confidence that, under proper management, may be reposed in it, seem to warrant the expectation of a great accession to our knowledge of these curious animated atoms —important from their immense numbers and universal occurrence.*

* Since the above was written, this subject has been extensively cultivated. See the Author's last work on this subject, entitled *A General History of Animalcules; illustrated by* 500 *engravings.*

CHAPTER V.

THE ANIMALCULES, OR EELS, IN PASTE.

Vibrio anguillula glutinis.—*Müller.*

THE animals described in the preceding chapters emanate from parents, and although our knowledge in some cases is very limited, yet no doubt is entertained of that fact. With the present subject it was far otherwise; for, although we can procure this animalcule at any period of the year, yet we were unable satisfactorily to determine its primal production; indeed, it is one of those subjects which, until recently, seemed to favour the opinion of equivocal or spontaneous generation — an opinion utterly repugnant to sound reason.

Figure 2, *plate* 4, is a magnified view of a mature animalcule, whose real size is shewn in the small circle below it; *a* is the mouth; the light-brown balls, *c c c*, are particles of matter found along with them. If we suppose this full-grown eel bisected, several living young, with the other bodies, will be protruded. The

remainder of the group there represented is the result of such an experiment, and are all amplified to the same degree as the parent.

The infant animalcules present a similar appearance under the microscope to the premature young shewn in the engraving. At this period, their serpentine motions among each other, and their transparency, are the only characters exhibited. As they advance in growth, the alimentary canal becomes apparent, and then the embryo young, coiled around it within the animal, as shewn in the engraving. They are very prolific, as upwards of one hundred young ones may be counted in a single individual.

These animalcules may be procured at any season of the year, and will afford us a constant source of amusement. The little trouble and attention required for their preservation render them highly valuable as microscopic objects, all that is necessary for their support being a little fresh thick paste about once a month.

The paste proper for procuring these animalcules is made with flour and water *only*—that of the shops, containing resin and other matters, is unfit for the purpose. It must be made

very thick, and boiled; when cold, it should be well beaten, and stirred with a wooden spatula, which must be repeated every day, to prevent mildew on its surface, previously examining a portion with a magnifier, to ascertain if it contains any eels. If the weather be warm, a few days will be sufficient to produce them. When they are once obtained, their motion on the surface of the paste will prevent any cryptogameous growth, and it therefore requires no further attention. In like manner it will prevent its freezing in the winter. If the paste is too thin, they will creep up the sides. In this case, a portion of very thick paste must be added, to preserve them. When it is desirable to give them a fresh supply of food, it must not be put upon them; but they must be placed upon it.

To prepare them for the microscope, take a few drops of clean water, and put a small portion of the paste containing the eels into it. After it has stood a minute or two, the eels may be taken out and placed under the microscope, freed from a considerable portion of foreign matter.

It is advisable to have the sliders for containing these objects thin, so as to impede as

little light as possible; and they should be laid flat till the instant they are wanted, as the eels always sink to the bottom of the water.

As they are devoured by many of the aquatic larvæ, a few of them may be put into the slider along with the latter, which will add much to the interest of the spectacle.

CHAPTER VI.

THE WHEEL ANIMALCULE.

Vorticella Rotatoria.—*Müller.*

THROUGHOUT the entire range of the animal kingdom, there is no portion the contemplation of which calls into more active exercise the powers of the imagination, and produces in every uncontaminated mind higher feelings of admiration and delight, than that which comprehends those animated beings, the evidence of whose existence is not attainable by our unassisted organs of vision. Animals endowed with freedom of action, capable of selecting such situations as are most conducive to their well-being, possessing appropriate organs for procuring the food they affect, and evincing an instinct not inferior to many of the higher animals, contained in a portion of space too minute to be discerned by our visual organs, furnish sublime and striking examples of creative wisdom and power that must have remained for ever con-

cealed from our view but for the invention of the microscope.

The peculiar nature and curious forms assumed at pleasure by the singular creature that forms the subject of this chapter, have procured it the notice of most writers on the microscope; it may therefore need some apology for its introduction in this work. All, however, that it appears necessary to state, is, that the figures given of it by preceding authors are in many particulars devoid of accuracy, and their description of some of its functions so mistaken, that the Doctor's drawings may be taken as a fair example of our advancement in these pursuits, while at the same time it is an object the study of which is always pleasing and delightful.

The wheel animalcule is met with in vegetable infusions, especially in that of hay; in the red sediment left by rain-water passing over leaden gutters, immersing it in clean water, in ditches surrounded by vegetation, and not communicating with sewers, and in shallow ponds. They are found most abundant about farm-yards, in collections of stagnant water, covered with weeds and confervæ, and are at their greatest perfection during June, July, and August.

They are very fond of sunshine, and on a cloudy day are seldom to be taken, as they descend to the bottom of the water and conceal themselves in the mud, or among the roots of aquatic plants. After a few days of fine hot weather, the pools in which they reside being partially evaporated, they become so numerous as to colour the water. They now attain their full size, and the richness and intensity of their colouring are at their maximum; the latter, however, they lose in a few days, if confined in a small vessel. Some specimens which I measured in this state, taken about the middle of June, were full *one-thirtieth* of an inch in length, while the largest bred in artificial infusions seldom exceed half that size. They were very numerous; a single drop of the water taken up on the head of our feeding-pin (see "Microscopic Cabinet") contained about thirty animalcules. They may be preserved alive for a considerable time, if occasionally supplied with a little hay. Some of those from which the drawings about to be described were taken, have been kept five years in a glass vase; their descendants, however, are much smaller, and have become perfectly colourless and pellucid.

The minuteness of these creatures renders it

necessary to employ a magnifier to discover them. The best method to collect them is to take up a little of the water we wish to examine with a ladle, and pour it into a wide-mouthed glass phial, and examine it with a hand microscope. As they soon attach themselves to the sides of the bottle, they are easily detected. In this way fresh portions from different waters must be successively examined, till a sufficient number is procured. For observation under the microscope they are best applied to the stage-glass by the feeding-pin above referred to, covering the surface with another plate of thin glass, to prevent evaporation, and to render the surface plane, or they may be put into an aquatic live-box.

The most usual form which these animalcules assume is that shewn in *plate* 5, *figures* 1 and 2. The first figure represents a full-grown specimen, the second the same when young. Taking the average length of the mature Vorticella at one-fortieth of an inch, the superficial amplification of the drawings will be 25,600 times, or 160 in length. It is under the form of *figures* 1 and 2 that it exhibits those curious rotatory organs from which its name is derived. When these wheels are protruded, the breadth

of the head is equal to that of the body; but when the animal assumes the form shewn in *figures* 3 and 4 of *plate* 6 (which are magnified in the same proportion as those in *plate* 5), it is much narrower.

A favourite speculation among philosophers is whether the wheel of this animalcule actually revolves, or whether it is a visual illusion. I am inclined to believe it is the latter.* Dr. Ehrenburgh informs us, that in the Vorticella senta the cilia are attached to several globular bodies, which are connected to the inside of the animal by slender filaments.

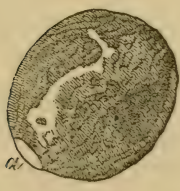
The form of the eggs is oval; several of them are shewn among the green matter at the bottom of the drawings. They are sometimes of a pink colour, at others of a deep golden yellow, with their surface beautifully granulated. They are deposited in rows by the parent, and may often be seen adhering to the sides of the vessels in which they are kept. The best method to observe them is to place the bottle on a stand.

The posterior extremity of the body is colourless, and furnished with two pair of retrac-

* See Dr. Faraday's Observations, in the "Journal of the Royal Institution."

tile feet-like processes. By the assistance of these appendages it attaches itself, as shown in *figure* 1, at *e*, and thus preserves a steady position, while the wheel-like organs are in motion. Sometimes it attaches itself like a common leech (*Hirudo medicinalis*), and moves from one spot to another, alternately fixing by the head and tail, and bending itself, as shewn in *figure* 3, *plate* 6.

The apparent joints *c*, *c*, *c*, *c*, in the various figures, are formed at the will of the animalcule; they do not appear to be confined in number or situation; the integument (*c*), where a joint is



produced, are drawn within the parts above, and slide out like the tubes of a telescope, when the joint disappears. It is this power that enables it to assume the form of a sphere, the head and tail being drawn within the body. This is shewn as nearly accomplished in *figure* 6, the toes (*g*), however, being still attached to a stem. In *figure* 7 it is entirely withdrawn, and forms a ball, in which state it moves about spontaneously, and exhibits only the vortex (*a*), which is also seen in *figure* 6.

The folds and external markings which present themselves in these forms exhibit the manner in which the body has contracted, and require attention to develope them. It is while in the form of *figure* 7 that they remain torpid. So great is their tenacity for life, that Leeuwenhoek states, and it is confirmed by Baker, that, having kept some of the sediment containing them, found in leaden gutters "as dry as clay," for twenty-one months, when infused in water, multitudes soon appeared, unfolding themselves, and putting out their wheel-like organs in search of food. These creatures feed on small animalcules and vegetable matter, some of which is seen approaching it in the direction of the arrows, *figure* 1. In preserving them, care

must be taken that the decomposed vegetation does not accumulate, and a little fresh water must be added occasionally, preferring rain-water. A stem or two of new hay may be added from time to time, and the old removed. The water fleas (*Daphnia pulex*, *Müll.*) and the Cyclops quadricornis devour them with avidity, and must, therefore, be excluded from the vessel in which they are kept.

CHAPTER VII.

ON THE GREEN AND BROWN POLYPE.

Hydra viridis et grisea.—*Linné.*

The remarkable simplicity in the organization of this creature, its limited functions and singular method of reproduction, form a striking contrast to the grand and beautiful machinery exhibited in the structure of the superior grades of the vertebrated animals. The perfect developement of their nervous system; the intricacy of construction in their apparatus for producing a double circulation, for the assimilation of their food, and the elimination of their old and useless parts, are among the principal means by which they perform those internal functions of which the polype is either wholly destitute, or performs in the most simple manner.

The interest attached to these creatures, from the station they hold among organized matter, apparently partaking in many respects both of

the vegetable and the animal nature, is abundantly attested by the voluminous descriptions of them that have appeared since their discovery by Anthony van Leeuwenhoek in 1703, and the investigation of their structure by Mr. Trembley, in 1740. Mr. Baker has devoted a moderate octavo volume to it; I have therefore fewer novelties to offer. My principal object is to present a more accurate and complete graphic representation of them. In so doing, it may be remarked, that the figures of this animal that are already before the public have a closer resemblance to it than is generally observable in portraitures of living miscroscopic subjects, and shows the verity of Dr. Goring's remarks on the difficulties of making drawings from living animals.* This creature being more quiescent in its habits, and simpler in its structure than any other with which I am acquainted, may account for its being more accurately delineated.

Plate 7 exhibits a magnified view of a group of polype in different states of contraction, and some with their prey within them; the small circle shows them of the real size.

The polype is composed of a granulated gela-

* See "Microscopic Illustrations," Exordium.

tinous tube, gradually tapering from the superior to the inferior extremity. The former or mouth is surrounded by a number of *tentacula* or feelers (*a*), arranged like rays around a centre. They are formed of a similar substance to the body, and like it are tubular. The number of these feelers, or arms, varies in different specimens from six to thirteen.

The mouth (see *b*, *figure* 2, &c.) assumes different appearances as it is more or less contracted. It is not furnished with any appendages for mastication, and its form is sometimes that of a conical or truncated papilla; at others it is hollow, and has an aperture in the centre capable of great enlargement, for the reception of its prey, as shown in *figure* 4.

The tail (*c*), which forms the posterior extremity of the body, is slightly dilated for increasing the surface of attachment. Although it appears perforated, nothing is observed to pass, the refuse of the aliment being regurgitated. It seems only designed for attachment, and to assist the animal in changing its place.

The whole internal surface of this animal performs the office of a stomach, or digestive organ. The food, when it consists of small pieces, and the nutritive juices when large, are

observed to move along the arms and body by the contraction and dilatation of the animal, like the peristaltic motion in animals which have a separate digestive cavity. No circulating or radiating system is therefore necessary for conveying the nutritive portion of the food to the different parts of the creature, each portion performing that office for itself. The small granulated bodies diffused throughout the substance of the animal are probably the glands, by which the assimilation of the food is effected —an opinion which is strengthened by the fact that the colour of these granular bodies approximates to that of the food, while the other parts of the animal are colourless.

No nervous or respiratory organs have been discovered in these creatures; indeed, I conceive the latter function, if necessary in animals of this kind, may be amply performed by absorption at the surface of the animal itself, as this surface is vastly greater in proportion to the mass of the animal than are the lungs, compared with the body of the higher orders of animals.

They move about from place to place by alternately fixing themselves by the head and tail; they can descend or ascend in the water at pleasure; they also move along the surface of

the water, and suspend themselves thereon either by the arms or tail.

They feed on small crustacea, worms, and larvæ, but they do not refuse small pieces of raw meat, with which it is requisite to supply them, when there is a dearth of other food.

When in search of prey they stretch out their arms and body to the utmost, and spread the former in various directions, thus presenting a large surface to entrap it. *Figure* 1 shews a green polype extended for this purpose. As soon as an animal comes within their range, they entwine their arms about it, and afterwards, by contracting them, bring it to the mouth and devour it. It sometimes happens that the velocity with which their prey is moving prevents the polype from securing its victim. In such cases I have observed the little animal, after the attack, sink in the water apparently lifeless, and remain so for a few seconds before it resumed its wonted activity. From this singular fact, I am induced to imagine that the polype possess the power of giving minute electric shocks, similar to some fish and insects; for in no other way can I account for the momentary torpor of such active little animals as the water-fleas (*Daphnia pulex*) and the Cyclops,

after coming within its reach; and this is the more probable, as their prey, even when it consists of worms (whose tenacity for life is well known), is instantly deprived of life, and no weapons of any kind can be discovered.

When they have devoured their food, they generally contract themselves, as represented in the drawing, *figure* 2, and partially contracted at *e*, *figure* 3. They are very sluggish during the process of digestion, and the nutritive fluid is dispersed over the whole internal surface both of the body and arms, imparting to them a coloured appearance.

The young are produced by shoots growing out of the different parts of the body of the parent, as shown in *figures* 1 and 3. They do not possess any sexual distinctions, and the power of reproduction is not confined to any particular part of the animal. When the creature is well fed, and the weather warm, it is very prolific, three or four germinating at the same time from a single individual, and others again sprouting out of these while attached to the parent. When a young one is about to be produced, that part of the animal from which it is to emanate increases in size, and projects, as shown at *d*, *figure* 1. After it has increased

sufficiently, the head is protruded, and the tentacula issue forth. The young one then supplies itself with food in the same manner as the parent (see *e*, *figure* 3). Until nearly matured and thrown off, there is an internal communication between the parent and the young, and they seem to possess a sensation common to both, for, if one be disturbed and contract, the other immediately does the same.

In the autumn it is said to produce eggs at the sides, in the same manner as the young are formed in summer. This I have been able to verify, though nearly all the polype that I have kept propagated in the way first described.

The most remarkable fact relative to these creatures is, that they can be cut asunder, and each part will reproduce the deficient parts, and form a perfect animal. The best account I have seen of experiments on this subject is given by Baker in his "*Natural History of the Polype*," before alluded to. His results, however, have been discredited by several intelligent observers; I have therefore made some experiments on them myself, and find them agree with his statements in every material point: a description of the details of one may not be uninteresting.

On the 22nd of August (1831) I selected a brown polype out of a glass vase containing a good supply of them, none of which had more than seven arms. The individual selected was then laid on a plate of glass, with a drop of clean water. Having provided myself with a good Whitechapel needle, and ground the pointed end so as to form a cutting edge, I severed the polype obliquely, the *superior* part comprising the greater portion of the head and four arms; the *inferior* part being the tail, and the remainder of the head, with two arms. These pieces were then put into a four-ounce phial of water, with a few small crustacea (*Daphnia* and *Cyclops*), where they sunk to the bottom apparently lifeless. Three hours after the operation I examined them (without disturbing the vessel), and found them in the same inert state. Twelve hours after this, I found the inferior piece attached to the side of the phial by its tail, with its arms extended in quest of food, the superior one still remaining at the bottom, but with its arms extended like the other. On the 24th, a new tail was completed to the superior portion of the polype, and the rudiments of additional arms were developed in both; they appeared in good health. The third day

the new arms were nearly of the same size as the others, and in less than a week each polype had a young one shooting from it.

The most curious circumstance connected with this experiment was, that the two new polype had each *ten arms*, while that from which they were produced, as well as those that were in the same vessel, had only six or seven.

It may not be inapposite to append here a few remarks on the proper method of preserving polypi.

They thrive best in a large vessel. A glass cylindrical jar, holding about three quarts, will answer the purpose very well; I have kept them for several months in a vessel of this description.

Although they do not seem to possess any visual organs, yet they appear sensible to light, and prefer that side which is most illuminated.

A fresh supply of water must be given them occasionally. If it cannot be procured from the pond from which they were taken, river-water should be substituted, always keeping a *small* quantity of *live* vegetation with them.

The common duck-weed will answer this purpose; but not so well as most other aquatic plants, as it is so rapidly decomposed in hot weather.

Before changing the water, the polypi must be removed by a feather into a goblet of the same water, in order that the sides of the glass may be well cleansed from the dirt and spontaneous confervæ which adhere to it; for, if these are permitted to accumulate, the creatures will not thrive, although a due supply of food and fresh water be afforded them.

Small larvæ, crustacea, or worms, must be supplied them, or in the absence of these small snails (*Helix planata*), or pieces of raw meat cut very small, and carefully dropped into the water over the place where they are situated, that it may fall within their reach.

In cold weather they must not be exposed too near the window, as they are very tender, and become torpid.

CHAPTER VIII.

THE LURCO, OR GLUTTON—A DIAPHANOUS SPECIES OF NAIS.

The transparency of this delicate subject, exhibiting all its internal conformation, added to its sloth and gluttonous propensities, are its pre-eminent features as a microscopic object; while its perviosity to light enables us to perceive the action of every muscular fibre. The curious structure of its stomach, or rather series of stomachs, is particularly worthy of notice; their contraction and dilatation, with their prey moving alive within them, as seen under the microscope, give to this object that intense interest, and produce that high gratification, for which we might seek in vain without the aid of that instrument.

The Lurco is generally found, during the spring and summer, among masses of partially-decomposed plants. I first met with it in a trench of clear rain-water, that had drained from a field of recently-mown grass. It was a hot day in June, and during sunshine. In

such weather they come to the surface, but, when the atmosphere is cloudy, they remain on the sediment at the bottom of the trench or pond — a circumstance which renders them difficult to be procured. When found at the bottom, they congregate in clusters, and, to the unassisted eye, resemble short filaments of vegetable matter, interwoven with each other. As their motions are slow, they may easily be mistaken for a mass of decayed weed. They may be preserved alive for several months in a glass vase, where their habits can be observed without disturbing them, and, when plentifully supplied with food, they rapidly increase in numbers and size. They do not undergo any transmutation. Those I caught in June were about two-tenths of an inch when extended, and about half that length in a contracted state. The vase in which they were kept held about three quarts, and was well supplied with small monoculi (*Daphnia* and *Lyncei, Müller.*) In October, four months after they were caught, they had become exceedingly numerous, and they congregated together in large masses, and many of them measured six-tenths of an inch when extended. Several of the larger ones, when examined under a microscope, had nume-

rous small diaphanous globular bodies, of various sizes, irregularly disposed around the second and succeeding stomachs. They gave the object a very peculiar and interesting appearance, and as they did not appear in the young specimens, one of which is shewn at *fig.* 1, *plate* 8, it was natural to mistake them for the ova; though it is stated that all the species of the Nais propagate by division; hence it is highly probable that these globular bodies are glands, secreting the nourishment imbibed from the contents of the stomachs.

The general aspect of this creature is not unlike a worm, and, like it, there is no division or neck between the body and the head. The mouth (*a*) is furnished with a row of fimbrella, which appear to possess tactual feeling; its shape, when open, is that of a pear, the radial muscular fibres, which are distinctly perceptible, being stronger at the inferior side. By the contraction and dilatation of these fibres, the pharynx is opened or closed. It has no feet, but small fasciculi of delicate hairs, or seti, at various distances, along its inferior side, and a larger cluster under the mouth. The œsophagus (*b*), connecting the cavity of the mouth with the first stomach, is capable of great and

instantaneous expansion, and is never completely closed, for its prey, which it always swallows alive, may be observed moving about in the first cavity, and endeavouring to make its escape through the contracted opening. All the digestive cavities or stomachs are preserved in their proper situation by a transparent muscular annulus between each of them. These diaphragms possess considerable contractile power, and are attached by their outer circumference to the muscular stratum, under the skin of the animal, while their inner margin surrounds the contracted parts of the alimentary canal, and is fastened to it. The fibres of these muscular plates diverge like rays, analagous to those in the iris of the human eye, and vary the aperture of the stomach, like the pupil of the eye, in the latter case. At *b* is situated a pulsatory organ, which terminates in two nervous lobes; these are scarcely discernible in the young specimens, and are not represented in the drawing.

The digestive power of the stomachs must be very considerable, as the food which they prefer is crustaceous. They will often devour monoculi greater in diameter than their own bodies, and that with a degree of rapidity and insatia-

bility not inferior to the *Boa Constrictor*, with whose manner they assimilate. It moves its head with a sluggish motion, and, when filled to repletion, is altogether inactive. The mouth is not possessed of any organs for mastication, nor has it any weapons of defence. So great is the voracity of this creature, that I have seen a middle-sized one devour seven Lyncei (similar to those shewn at *figure* 3, in the same plate,) in half an hour. Five of these were moving about in the first cavity, at the end of that time; the other two, having passed into the second, had become exhausted. In the drawing (*plate* 8, *figure* 1), at *c c*, are seen three of their prey, and the refuse of others at *d*.

The slow motion of this creature admirably adapts it for inspection under the microscope, where the motion of an object is always augmented in the same ratio as the magnifying power of the instrument. An amplification, equivalent to a lens of about a quarter of an inch focal length, is amply sufficient to give a general view of its organization. Its management in the solar microscope requires considerable tact and address, on account of its delicacy, as the heat of the sun soon kills it, and separates its parts in a few seconds, if brought too

near the focal point of the illuminator. They are rather scarce objects, but, with care, may be preserved alive for a considerable time.

CHAPTER IX.

THE SATYR.

Amymone satyra.—*Müller.*

If a contemplation of a variety of forms in the animal creation will produce pleasure, and excite our admiration of the boundless powers of their Creator, there is no class of beings so various in their external or internal forms and structure as those whose details are developed by the aid of the microscope. Larger animals in general possess the same number of members, varied only in proportion and situation, while the minute ones not only possess these variations in every possible degree, but the number of their members and their organization are varied in a thousand different ways.

The subject of this chapter illustrates the general characters of the univalve Entomostracea, of which there are several species. Its curious form, and the disposition of its mem-

bers, give it a novel and interesting aspect. The magnified view of the inferior side, given in *plate* 8, *figure* 2, exhibits a full-grown Satyr, as it is commonly seen on the side of a vessel of water in an upright position.

The real length of the specimen represented in the drawing was the *one hundredth of an inch*. In the infant state they are much smaller, and their great transparency at this period renders them highly valuable for the microscope.

These creatures I have found most abundant in the spring, during the months of March and April. They may be taken in shallow pools of clear water, near the surface, among thriving aquatic weeds and plants, by means of a basin or cloth net. When the water is putrescent, or the vegetation in a state of decomposition, it will be useless to search for them.

The back of this creature is covered with a delicate transparent shell, while the inferior side is unprotected and membraneous. Its appearance, when viewed in profile, much resembles that of the tortoise, and the under view, shewn in the drawing, is not unlike the form of a horse-shoe. Attached to the lower part, and radiating as from a centre, are four legs and two antennæ. In the middle, between the two latter, is posited

the mouth and a single eye (*a*) ; the latter is of a deep black colour, surrounded by a quadrangular crimson socket. The two antennæ (*b*) consist of four joints each ; their ends are furnished with bristles. The legs (*c c*) are separated at their second joint, and terminated by strong claws. The peristaltic play of the alimentary canal may be observed in the dark parts running along the middle. The tail (*e*) consists of two processes, each terminated by strong spines.

In swimming it makes sudden starts or jerks, and moves its feet with great celerity ; at other times it creeps along the sides of the vessel.

Müller has described* five other species of the Amymone, some of which closely resemble the genus Nauplius, excepting that all the species of the latter have six feet. Joblot gave the name of Satyr to this creature, from its likeness to a face, and Baker has continued it, thinking it not inappropriate ; the two spots (*d*) "forming the eyes, and the dark alimentary canal between them," (which he has represented like a wine decanter inverted,) "answering to the nose, and the tail forming a piqued beard."

* See *Entomostraca seu Insecto Testacea*, 1785.

This idea must have been formed when viewing it *inverted,* as in a compound microscope or engiscope. (*See* concluding remarks of Chapter XI.)

CHAPTER X.

THE ROUND LYNCEUS.

Lynceus sphericus.—*Müller.*
Monoculus minutus.—*Linné.*

This creature is generally known by the name of the small Monoculus, though a very slight examination will convince us of the impropriety of this appellation, as its two eyes may be very distinctly seen. Müller, from whom I borrow the name at the head of this chapter, has with more propriety classed it with his Binoculi.

The shells of the Monoculi, as well as that of the present subject, are beautifully marked with reticulations of various forms, and present under the microscope diversities in structure highly worthy of investigation. The mosaic appearance of the shell of this Lynceus closely resembles the joints in masonry or brick-work. In the Monoculus vulgaris *(Daphnia pulex, Mül.)* the shell is covered with diamond-shaped reticulations, while in other species it is divided into hexagons and other angular figures.

The shell, which is perfectly transparent, consists of a single piece, no hinge or joint being perceptible; it, notwithstanding, possesses sufficient elasticity to permit the animal to open it at pleasure, in a manner similar to the common muscle *(Mytillus edulis)*. The two edges of the opening are seen in the drawing near *c*, *plate* 8, *figure* 3, which represents a magnified side view of this creature. The two eyes (*a*) are of different magnitudes, and their black colour forms a striking contrast to the surrounding parts. They are embedded in the shell, and consequently protected by it. The rostrum, or beak (*b*), is pointed, and partakes of the general convexity of the shell. Beneath this is situated another process, similar in appearance, but shorter; at its extremity are three setaceous bristles, which probably perform the office of palpi; below these are situated the two antennæ (*c*), each terminated by similar bristles, but longer. The false feet, or *branchiæ*, are four in number, and disposed in a single row within the shell; they are hirsulate, and terminate like the antennæ. When in motion they cause the animal to revolve, which it can accelerate by the action of the process (*d*) against the water. At other times the false feet

appear to assist the animal in creeping along the stalks of plants, to which they attach themselves by closing their shell. In cold weather clusters of them may be observed around the stalks of aquatic plants, giving them the appearance of ice-plants.

The process (*d*) is ciliated along its posterior margin, and armed with two strong claws, and the curious trident appendage at the base is attached to it. The ovaria are of a greenish blue colour, and their surface resembles the form of the mulberry. The convolution of the alimentary canal, with the food within it, are clearly perceived from one extremity to the other. The most remarkable organ, and one that has hitherto escaped notice, is the small oval body behind the head; it has a quick pulsatory motion.

The Lyncei feed on animalcules, and in their turn are preyed upon by aquatic larvæ and water-beetles. They are the choice food of the Lurco, a magnified view of which, with some of them within its stomach, is shewn in *figure* 1 of the same plate. They are seldom met with in autumn, being the earliest to appear and disappear in the season. They inhabit the shallow parts of ponds, and collections of rain-

water. The young play near their parent, and at the approach of danger swim for protection within the shell of the mother, which she, conscious of their feebleness, immediately closes.

CHAPTER XI.

THE FOUR-HORNED CYCLOPS, OR SMALL WATER FLEA.

Cyclops quadricornis.—*Müller.*
Monoculus quadricornis.—*Linné.*
Pediculus aquaticus.—*Baker.*

The Author of Nature, to whom all things are alike easy of execution, as if intending to teach man a lesson of humility, and that no part of creation, however minute, is beneath his consideration, has conferred on those animals, that are barely perceptible to our unassisted vision, more elegance and variety of form, more richness in their colouring, and more beauty and exquisite finishing, than on the whale or the elephant, which mainly excite our admiration by the magnitude of the mass of living matter they present to us.

The little crustaceous animals, which form the subject of this chapter, may be found at all seasons of the year near the surface of the

water: they are, however, most abundant in July and August. I have collected great numbers of them on a warm day, in the latter month, in a small cloth-net, immersing it about an inch below the surface. They are mostly colourless, in ponds covered with herbage, but in small collections of rain water, on a loamy soil, they are of a fine rich colour; they are never very numerous in waters frequented by the common water-flea (*Daphnia pulex*), though frequently met with in neighbouring pools.

In *plate* 9, *figure* 1, is a drawing of this Cyclops of its real size, and *figure* 2 of the same plate is a magnified representation of it.

The body of this creature is covered with crustaceous or shelly plates, which overlap each other, and admit both of a lateral and vertical motion between them. Their ends do not meet on the under side, but have sufficient space between them for the insertion and play of the organs of respiration (*a*). The rostrum, or beak, is short and pointed; it is a prolongation of the first segment or convex plate, which, terminating obtusely, forms the head. A little above the beak is embedded beneath the shell a compound eye of a dark crimson colour, nearly

approaching to blackness. The true form of this organ is difficult to determine. Mr. Baker gives it the shape of two kidney-beans placed parallel to each other, and united at their lower extremities. When viewed laterally it appears round, while in some other positions it is square.

On each side of the eye are inserted the antennæ; the superior pair is longer than the inferior ones. They are composed of numerous articulations, from each of which proceed two or more setaceous bristles. In some species the form of these organs distinguishes the sexes, as in the *Cyclops rubens*, the males having their right antennæ enlarged, forming a bulb about the middle, as shown in *figure* 4 of the same plate.

These creatures move by sudden starts, though they creep along the stalks of plants, in which they appear assisted by the feet or branchiæ (*a*). These members, however, are generally in motion, from which it is difficult to observe their precise form while the animal is alive. One of them on a larger scale is shown at *figure* 3. They are mostly pellucid, but occasionally of a greenish blue colour.

The ovaria consists of two bags, presenting a similar appearance to clusters of grapes, and being of considerable magnitude, compared with the size of the animal, they give it a novel and peculiar character. The eggs are of a globular figure, and enclosed in a transparent membrane, independent of their shelly ovarium. The centre of each egg is of a deep opaque colour, which in some specimens is green, in others red. Their number increases with the age of the parent, and when sufficiently matured, the embryo of the future animal may be perceived under a deep magnifier. At the termination of the alimentary canal the tail is separated into two portions, and the ends of these bicaudal processes are furnished with branched seti, which form a beautiful plumed appendage.

The coloured markings on the shell of these creatures vary in different specimens, as also do the colours of the ovaria. The majority are pellucid, and do not possess the beauty of the bright variegated red specimens from which the drawing was taken. Some are of a blueish green, others are red, with the ovaria green.

Since the above description was first published, foreign naturalists have paid great attention to the Entomostracans, and have ascertained

that they undergo transformation. It appears, from these observations, that the Satyr, described in Chapter IX., is the young of the present subject.

CHAPTER XII.

THE SMALL CYCLOPS, OR VAULTER.

Cyclops minutus.—*Müller.*

The facility which these creatures display in transporting themselves through the watery element, combined with the elegant and graceful form they assume in effecting these motions, renders them highly amusing and interesting. The popular name of this little animal is derived from its motion, which is usually a succession of leaps.

They seem to possess great discernment and cunning, for, if approached, they remain motionless on the plant on which they reside, in the apparent hope that they may be overlooked; but when a fit opportunity occurs they suddenly inflect themselves, and spring away with a kind of vaulting leap.

They inhabit various species of confervæ, and may often be met with in great numbers on the stalks and underside of healthy duck-weed growing on the surface of water. They are most numerous in April and May, and disappear as the heat of the season increases. They will not live in stagnant water containing much decomposed vegetation, and require therefore to be kept for observation in a large vessel of clean water. They are easily caught, after a shower of rain, on the under surface of the duck-weed, by taking a little out with a basin or cloth-net. When found, they appear busily engaged in search of prey, moving about with great activity, and examining every portion of the plant in the most scrutinizing manner. In this pursuit the body is not inflected, as exhibited in the magnified representation of it given in *plate* 9, *figure* 5, but is kept in a straight crawling position. Their natural length is about the three-hundredth of an inch. In the drawing, which is the first published in this country, Dr. Goring has chosen the deflected position, as giving a more interesting view of the character of the animal.

The construction of the shell is similar to that of the quadricornis, but it has a greater

number of segments, and is more gracefully tapered. The compound eye is embedded in the shell. The antennæ are not composed of so many articulations as in the quadricornis, and the inferior pair of palpi are more plumose at their extremities. The most prominent distinction between the two species (independent of the difference in size, the present species being the smallest of the Cyclops), consists in this having a single branchial or respiratory organ under the rostrum; it has also ten legs, and the female carries a single cluster of eggs under the abdomen, somewhat resembling the wolf-spider. In some specimens which I have examined, the form of the respiratory organ was similar to that I have shown at *figure* 6. It is in constant motion, and produces a current in the water towards the animal.

The legs, five only of which are seen in the side view, *figure* 5, are so accurately depicted that verbal description would be superfluous. The setaceous bristles forming the tail are not so numerous as in the quadricornis, but conjoin with the body in producing the graceful figure it exhibits; while its intensely bright colour serves to heighten the delight and grati-

fication experienced in an attentive examination of this interesting specimen of the minutiæ of nature.

CHAPTER XIII.

A SMALL FRESH-WATER SHRIMP.

Gammarus grossi.—*Leach.*

This creature belongs to the family *Gammaridæ* of Dr. Leach. In some respects it accords with the genus *talitrus*, the first three joints of the superior antennæ being shorter than the inferior ones, while it agrees with the genus *gammarus* in having bundles of spines at the joints above the tail.

They are often very abundant in ponds and rivulets during the spring, and in fine weather congregate among confervæ and water-plants. If kept a few days in a vessel of clean water, they become more transparent, and assume a more interesting appearance under the microscope. The body is curved and compressed laterally; it consists of ten segments of a variegated cinerous colour, with fine touches of bright red. The dark alimentary canal is finely

displayed when the creature is well fed, and a pulsatory motion is observable along the back. The head is broad, and has a cluster of small eyes embedded on each side. These eyes are jet black, set in a dead-white socket. In the species at present under our notice, the cluster is circular, but in the *Gammarus locusta* they are arranged in a lunate form. The antennæ are four in number, and are inserted in pairs. The three basal articulations are larger than the others, which are short and numerous; their inferior side is studded with a row of fine bristles, which, ordinarily, appear single, but when viewed under a lens of one-tenth of an inch focus, are found to consist of clusters of three each, of unequal length. The legs are fourteen. In *plate* 10, which represents a side view magnified, only seven are shown, the others being omitted, to prevent confusion. They are furnished at their insertion with laminated plates (coxæ), whose structure is worthy of examination, and requires a good microscope and careful management to develope. They are transparent, having their inner surfaces covered with rows of bent spines, which, viewed in some positions, appear like lines; in others, like dots. The first four legs are monodactyle, and increase

in magnitude towards their extremities; the next two pair are small and tapering, and the last six are the longest. They are all set with clusters of fine hair. The three pair of branchial organs which succeed the legs are in constant vibratory motion, and play between the lamelliform plates before described; they are furnished with fine bristles at their extremities, and along their sides: the latter are not shown in the drawing, nor are they easily detected in living specimens; I first observed them in the exuviæ. It is worthy of observation, that the function of respiration in these creatures is performed externally. The branchial organs playing between the plates bring fresh portions of water, containing air, to be absorbed by their internal surfaces, answering the office of lungs in the vertebral animals.

The tail consists of two caudal processes, terminated by spines; they are attached to the body by four intermediate segments, the first and third of which are furnished on the inferior side with a double appendage, as shewn in the drawing.

These crustacea are very voracious, yet they can live for a considerable time without food. I put a few aquatic Moluscæ and a Nais with it in

the same vessel. It first endeavoured to avoid the rapid wriggling motion of the latter, fearful of getting its antennæ entangled with it; but, after a few minutes had elapsed, the Nais became more quiet, when it seized it by means of its monodactyle legs, and devoured it in a few seconds, rejecting only the skin. The same evening I put about a dozen more specimens into the same vessel, and in the morning they were all devoured; the Moluscæ it would not feed on, though afterwards kept without other food.

They may be preserved alive during the winter, and bred in a large vessel of water. The eggs are numerous, of an oval figure, and at first quite transparent. In a short time the rudiments of the future Gammarus are discernible near the centre of the egg, which then loses its transparency; they are hatched in the spring.

They usually swim in a curvilinear direction, and seldom in a straight line; they are exceedingly nimble; they often swim in pairs, and are said to assist each other in casting their exuviæ. If well fed, they grow rapidly, measuring half an inch in length without the antennæ; when, however, they are about a quarter of this size,

they are in the best condition for the microscope. The exuviæ may be kept between slips of glass, and afford very delicate and beautiful subjects under moderate amplification.

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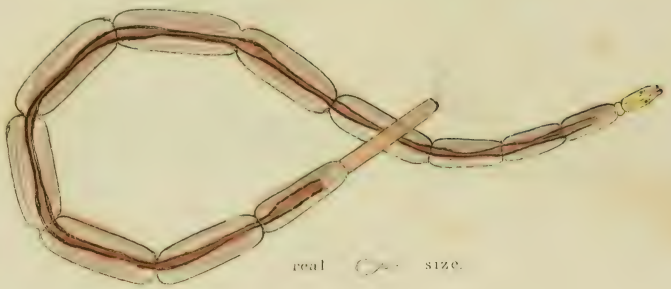

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Fig. 1.

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Fig. 2.

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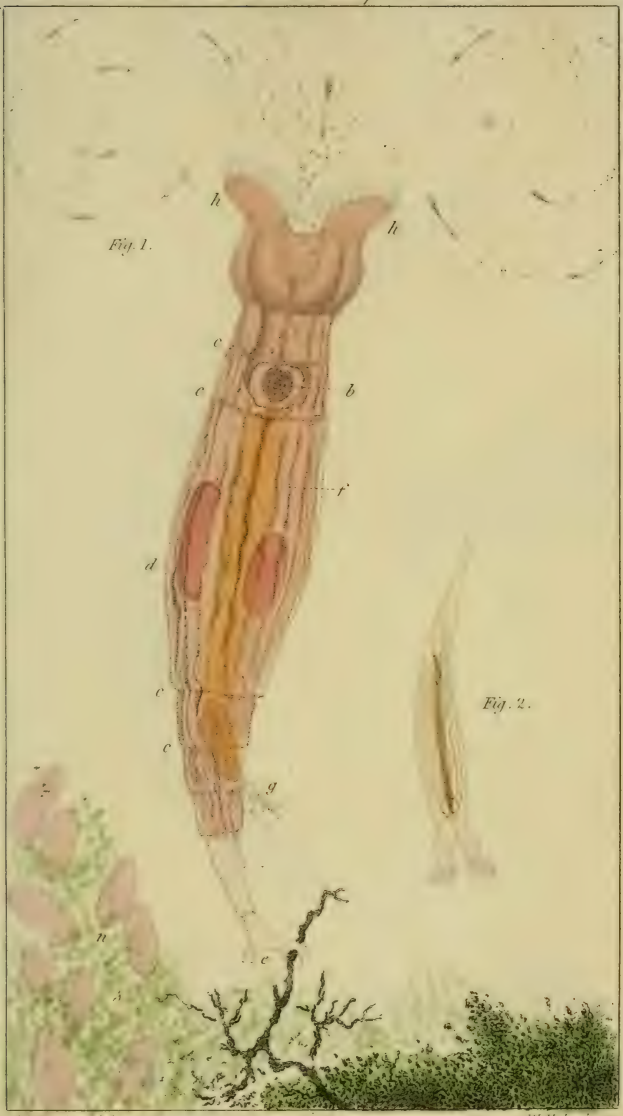

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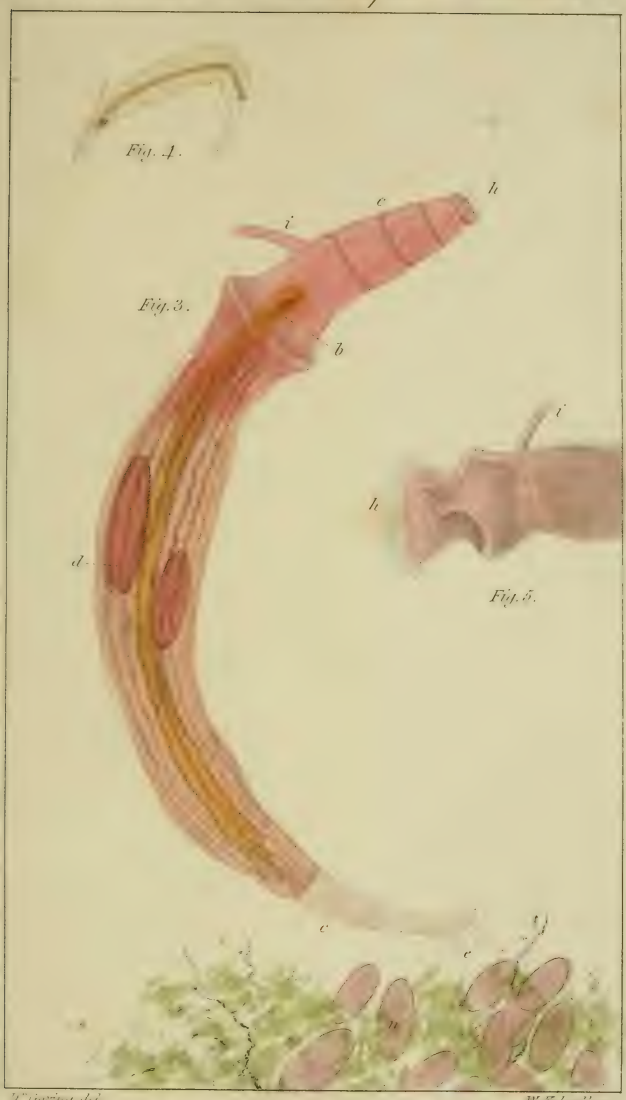

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Fig. 3
Fig. 4
Fig. 2
Fig. 5.
real size.

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Fig. 1.

real size.

Fig. 2.

Fig. 3.

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